

**Command and Control Experimentation
Lessons Learned
From the US Army Division
Advanced Warfighting Experiment
(DAWE)**

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1. Introduction

1.1 Purpose

The purpose of this paper is to identify command and control (C2) experimentation lessons learned from the data collection and analysis processes of the US Army Division XXI Advanced Warfighting Experiment (DAWE). These lessons learned will assist the analytic and data collection communities in conducting future Advanced Warfighting Experiments (AWEs) and the Army Experimentation Campaign Plan (AECPP). This document provides a background of the DAWE, an overview of the data collection and analysis processes, and the C2 experimentation lessons learned during the planning, execution and post-event phases of the DAWE. The lessons learned section includes examples of the problems encountered and potential solutions. Lastly, this document highlights the general implications resulting from these lessons learned. *This paper is an edited version of a Technical Document (TRAC-TD – 0198) published by the TRADOC Analysis Center in November 1998.*

1.2 Background

The DAWE culminated a series of Advanced Warfighting Experiments (AWEs) conducted over the past several years by the Army to underpin the definition and development of the Force XXI Army. The DAWE, conducted from 5-13 November 1997 at Fort Hood, Texas, employed a Battle Command Training Program (BCTP)-like, command post (CP), warfighter exercise (WFX) with digitized division and brigade tactical operations centers (TOCs) in the field. The purpose of the DAWE was to experiment with a Force XXI-like division represented by the digitized, modernized, and trained experimental force (EXFOR) within a realistic warfighting environment. The 4th Infantry Division (mechanized) (4ID) was designated and configured as the EXFOR using a Force XXI division design, which included a new centralized combat service support (CSS) concept. The DAWE was portrayed in the Lantica scenario (force year 2003). The National Simulation Center (NSC) ran the simulation in a non-stop, free play mode to drive the AWE using the Joint Training Confederation (JTC) of models, modified to the degree possible to represent the modernized division and its operational concept and to stimulate the Army Battle Command System (ABCS) systems used by the EXFOR. There were no maneuver units in the field. The focus of the DAWE was on battle command (BC) and information operations (IO). The principal products of the DAWE analysis are the Initial Insights Report (IIR) published in January 1998 and the DAWE Final Report published in August 1998.

The DAWE was one of several key Army efforts within the Joint Venture (JV) axis of Force XXI. The other major analysis efforts on the JV axis were Division Design Analysis (DDA), which examined alternatives for the interim division design; Task Force XXI (TFXXI) AWE, which addressed digitization and other issues at brigade level; and a series of CSS evaluations to address the new Force XXI CSS concepts and enablers. Each JV effort had a different, yet complementary focus and approach to address specific areas of interest regarding the future division. Consequently, the DAWE was not intended to address every issue or area of interest regarding the design of the division.

2. Data Collection and Analysis Processes

This section provides an overview of the data collection and analysis processes, which formed the basis for the lessons learned presented later in this report. This overview encompasses the DAWE planning, execution, and post-event phases.

2.1 *Planning Phase*

This phase encompasses the time from initiation of the DAWE process until the execution of the exercise in November 1997, a period of over two years.

2.1.1 *Refining the Hypothesis*

The DAWE hypothesis, with its focus on BC and IO contributions, was developed by the Training and Doctrine Command (TRADOC) Joint Venture Office (JVO), in conjunction with the EXFOR Working Group (EWG) chaired by the TRADOC Commander. To assist in addressing the DAWE hypothesis, eight subordinate questions were developed to provide a focus and framework for the full set of issues and initiatives that were considered under the DAWE. These eight questions became known as the “Brown Card” questions that originated from the Joint Venture Analysis Management Plan (JVAMP) overarching issues. These Brown Card questions became the issue categories, which served to frame the data collection and analysis processes.

2.1.2 *Identifying Study Issues and Initiatives*

Within the scope of the hypothesis and the Brown Card questions, the DAWE provided an opportunity to address numerous specific study issues and initiatives. A “study issue” is a question to be answered through application of analysis and an “initiative” is a system and/or concept to be evaluated through experimentation for potential fielding. Proponents from the TRADOC battle laboratories, schools, and centers (as well as other outside agencies) nominated study issues and initiatives that were then screened and revised by a review board in August 1996. These proponents are called “issue proponents (IPs)” in the remainder of the paper. The resulting issues and initiatives were included in the DAWE Study Plan. A second review board in April 1997 reconsidered the DAWE issues and initiatives based on the TFXXI AWE results. The issues and initiatives that emerged from these two review boards were then addressed in the DAWE.

2.1.3 *Developing the Analysis Approach*

The analysis of the DAWE was organized and conducted from two principal perspectives. One was from the perspective of the division’s overall battle effectiveness, known as the “battle analysis.” This was also referred to as the “horizontal analysis” because it spanned the entire division’s operation during the successive battles waged during the exercise. The battle analysis was led and conducted by a select team of TRADOC Analysis Center (TRAC) military analysts, known as the Capabilities and Potential (CAP) team. Through partnering with BCTP and direct observation of the DAWE, the CAP team identified key battles and events of the DAWE

scenario that offered the most fruitful scenario opportunities for analysis of the capabilities and potential of the digitized division. The CAP team then examined the data collected and insights generated about those events by the BCTP observer controllers (OCs), subject-matter experts (SMEs), and the individual members of the CAP team. An SME is a representative from a TRADOC school and center (or other outside agency) used as an observer under the control of the lead agency for data collection, the Army Test and Evaluation Command (ATEC) Operational Test Command (OTC). ATEC was formerly known as the Operational Test and Evaluation Command (OPTEC). With this information and the assistance of the BCTP Battle Summary Cell, the CAP team generated a holistic understanding of the events within the operation and translated that understanding into potential Force XXI capabilities.

The second perspective was from that of the eight issue categories (Brown Card questions), referred to as the “proponent issue analysis.” This was also referred to as the “vertical analysis” because it delved more deeply into each of the eight issue categories within the division’s operation. The proponent issue analysis was led by TRAC and conducted by IPs and analysts assigned to address the issues and initiatives within each of the eight categories.

2.1.4 Developing the Data Collection Approach

ATEC (OTC) consolidated all data collection requirements into a data collection plan which identified, for each issue, the types of data to be collected and the corresponding sources of data in the DAWE. Principal sources included SME observations, instrumented data collection, JTC output, and surveys (i.e., prepared questionnaires and interviews). SME observations constituted the bulk of the data collected although the following agencies, all of which collected data subject to the control of ATEC (OTC), contributed key data elements. BCTP collected observations of the EXFOR across each of the battlefield operating systems (BOS). These were a valuable source of corroborative data for the battle analysis. The TRADOC Program Integration Office - ABCS (TPIO-ABCS) collected operational architecture data. The TRADOC Office of the Deputy Chief of Staff for Training - West (DCST-W) generated insights about training support packages (TSP). The Land Information Warfare Activity (LIWA) collected IO data from the World Class Opposing Force (WCOPFOR) perspective for their vulnerability assessment (VA). The Command and General Staff College (CGSC) collected data on emerging tactics, techniques, and procedures. The Program Executive Office for Command, Control and Communication Systems (PEO-C3S), using MITRE, collected ABCS performance data. IPs and analysts together used the data collected during the DAWE to develop issue-centric insights.

2.2 Execution Phase

The following paragraphs describe the daily rhythm at the DAWE including the data collection process and the analysis from both the warfighting and the analytical perspectives. This section also describes how the insights from these two perspectives were integrated.

2.2.1 Data Collection Process

ATEC (OTC), as the lead agency responsible for DAWE data collection, developed a DAWE data collection plan for development of a single database of data collected from the DAWE.

This plan was finalized in October 1997 after extensive meetings and workshops with issue proponents and analysts. The collection plan identified the data to be collected, collection methods to be used (observation, instrumentation, surveys, etc.), and the data collection responsibilities for each issue. ATEC (OTC) trained all SMEs prior to the experiment in the FXXI operational concepts, data collection and observation procedures and in the capabilities of the database management system to be used. During the DAWE, the SMEs recorded their observations on laptop computers that they were issued by ATEC (OTC). Their observations were collected (downloaded to the computer network) every six hours over the course of the DAWE. ATEC (OTC) was responsible for quality oversight of the data collection process, conducted quality control checks of the data and provided the data to analysts and IPs for reasonableness checks prior to locking the data into the database. Other data collected such as that collected from instrumentation, surveys, and questionnaires was also subjected to quality control checks. All data was then consolidated into an automated database immediately after the DAWE and ATEC (OTC) provided the resulting database after the DAWE to the analytic agencies for analysis. ATEC (OTC)'s data collection process was modeled after their data collection process typically used for tests.

2.2.2 Analysis During the Experiment

2.2.2.1 Warfighting Perspective

Within the context of the WFX approach, BCTP conducted a traditional battle command evaluation. They utilized OCs to assess the ability of the EXFOR to manage and integrate the BOSs (maneuver, fire support, intelligence, air defense, command and control (C2), mobility and survivability, and CSS). The TRAC CAP team contributed an assessment of the EXFOR's execution of the Force XXI patterns of operation from a warfighting perspective to the BCTP evaluation. The BCTP team chiefs worked closely with the CAP team to share, discuss, and interpret observations and derive appropriate insights. Typically, this was done twice daily, during the shift change meetings. BCTP presented the daily warfighting insights at the nightly general officer update briefings and at the after-action reviews (AARs) during the AWE. Upon completion of the operational phases of the DAWE, the CAP team also developed insights for presentation at the general officer updates in terms of the patterns of operation.

2.2.2.2 Analytical Perspective

The analysis effort during the experiment was based on data collected from various sources. The primary data collection effort used over 100 SMEs trained and managed by ATEC (OTC) and 60 BCTP OCs. The data collected by ATEC (OTC), BCTP, and others were consolidated into an ATEC (OTC) database, which contained over 6,000 SME/OC observations, interviews, surveys, etc. Daily during the experiment, analysts from TRAC, ATEC's Army Evaluation Command (AEC), and the Army Research Laboratory (ARL), with assistance from the issue proponents, reviewed the observations and other available data looking for trends and corroborating data points that suggested an emerging insight. A more thorough analysis of the data and the insights was conducted after the experiment (as discussed in paragraph 2.3). The Insights Authentication Group (IAG), which included TRAC, ARL, and ATEC (AEC), held a daily meeting to screen the emerging insights (developed by the analysts and issue proponents) to determine viable,

supportable analytical insights. The IAG reviewed each insight based upon the established criteria of significance to Army leadership, relevance to a DAWE issue, completeness, consistency with other observations, and whether each was supported by observations. Failing to meet these criteria, the IAG returned the insight to the submitting issue proponent and analyst for additional research. The CAP team representative at the daily IAG meetings provided the linkage between the warfighting and analytic teams and perspectives.

2.2.3 Integration of Insights at the Experiment

The CAP team was the primary integrator of the resulting analytical insights with BCTP's insights and observations to determine overall insights reflecting both the warfighting and analytic perspectives and to determine potential Force XXI capabilities. The analysts and issue proponents conferred on a continuing basis to analyze and integrate the SME observations. If the analyst or issue proponent found any problems with an observation's completeness, clarity, objectivity, and significance they submitted an anomaly to the SME asking for clarification, more information, or additional input for the observation. Once any problems with the observation were resolved, the lead analyst and the issue proponents reviewed the observations for possible integration into significant results called insights. After the IAG, the study director and the senior military analysts reviewed the analytical and CAP team insights, selecting those to be briefed at the nightly update briefing.

2.3 Post-Event Phase

The first product of the DAWE was the IIR, to be published within 30 days after the event. To accomplish this, the lead analysts developed three charts immediately after the event and before leaving Fort Hood for each issue category to identify the background, key emerging insights based on available data, and the doctrine, training, leader development, organization, materiel, and soldiers (DTLOMS) implications of those insights. These charts were consolidated into the IIR. Issue proponents and analysts then returned to their home stations and continued to analyze the data and to refine their insights, DTLOMS implications, and battle analysis. This process included reviewing all of the data to confirm the emerging insights and develop any new insights. The lead analysts then determined which insights were key and appropriate for inclusion in the Final Report. This data included the SME/OC observations collected at the DAWE, survey results, interviews, instrumented data, JTC output, and results from other organizations gathering information (BCTP, DCST-W, TPIO-ABCS, and 4ID). A DAWE Final Report workshop was held at Fort Leavenworth 26-28 January 1998 at which issue proponents, analysts, and other organizations gathering information at the DAWE briefed their key insights, answers to their issues, and DTLOMS implications to TRAC and other participating analytic organizations. The briefings and audience discussions facilitated the integration of the results. The issue proponents and analysts then refined their input based on the discussions at the workshop and submitted their final analytic results to TRAC for inclusion into the Final Report.

3. Lessons Learned

This section of the paper focuses on the data collection and analysis processes lessons learned from the DAWE. The lessons learned are based on a data collection and analysis after action

review (AAR) conducted on 14 April 1998 at Fort Leavenworth, Kansas. Participants in the AAR, and those providing input, were TRAC - Fort Leavenworth (TRAC-FLVN), ARL, ATEC (AEC), TRAC - Fort Lee (TRAC-LEE), TRAC - White Sands Missile Range (TRAC-WSMR), and ATEC (OTC). The following lessons learned, documented from the perspective of the DAWE Study Director, are presented for each of the three phases: planning, execution, and post-event.

3.1 Planning Phase

Data collection procedures typically used for operational testing should not be strictly applied to AWEs. Traditional testing protocols were applied to the data collection procedures for the DAWE. These protocols, in some cases, impacted the subsequent analysis process. Three particular impacts were observed as a result of this approach. First, to ensure operations in the TOCs were not hindered with an excessive number of visitors, direct observation and data collection by anyone other than SMEs formally designated and trained as data collectors was restricted. Direct observations by analysts and issue proponents assisting in the analysis of issues was limited. Second, the data collected during the DAWE was controlled and its distribution restricted (as is often necessary in a sensitive test of a developmental system) such that the timing and completeness of the real-time analysis process was impacted. The translation of subjective observations, once obtained from the SMEs, was difficult for the analysts who had had no direct observation of DAWE events. Third, the test-oriented data collection process was focused at too low a level of detail for an experiment that was based on subjective data collection and evaluation. The data elements to be collected in many cases were too detailed and too narrowly focused for the SMEs' examination of the division's command and staff operations. This resulted in a large number of data elements, leading to a large number of questions for many of the SMEs to answer. Some SMEs had up to 300 questions to answer, well beyond the scope of what they could reasonably do. In hindsight, maintaining the collectable elements at a higher, more functional level would reduce the number of questions that future SMEs would be required to answer.

Senior Army leadership's guidance is needed early in the planning phase and throughout the process. The DAWE planning phase began while the preceding TFXXI AWE was also still in its planning process. The attention of the senior leaders was clearly focused on that earlier significant event. Attention turned to the DAWE only after the TFXXI AWE was completed. The DAWE suffered because of this lack of attention. In particular, the issue development process lacked senior leaders' direction. Senior leaders' guidance was needed to narrow the focus of each of the eight overarching issues, which would have facilitated the issue development process. The process of obtaining senior leaders' guidance, through the process action team (PAT) meetings conducted by the JVO of Headquarters TRADOC, was inadequate. At the PAT meetings, each in-process team (IPT) lead (e.g., analytic lead, scenario lead, etc.) presented issues and concerns that the JVO was to elevate to the EWG for guidance or approval. Often times, guidance was not obtained and/or not conveyed back to the IPT lead. Increased involvement of senior leaders, particularly in the planning phase, would have resulted in an even better experiment. Also, senior leaders' guidance is required to help enforce the good idea cut-off date (GICOD) and everything in place date (EIPD). For instance, PEO-C3S was allowed to modify ABCS even after SIMEX I, which was long after the GICOD and EIPD. These changes

in ABCS caused NSC to make last minute changes in the interface modules between the JTC and ABCS and also hindered the training of soldiers on ABCS, which affected the performance of the unit.

Establish organizational responsibilities early in the process. All participants in an AWE need to know their specific role and the role of others to work effectively. For example, in the DAWE, the role of BCTP and their relationship with TRAC's CAP team conducting the battle analysis was not established until very late in the process (SIMEX II) although this relationship quickly developed and proved to be one of the most positive accomplishments of the analytical effort. Additionally, the responsibilities of some agencies (e.g., PEO-C3S, CGSC) collecting data from the DAWE, and their relationship with the lead for data collection, ATEC (OTC), was never well established. This lack of defined relationships caused problems in data collection and analysis. These problems included some agencies not providing their observations from the DAWE for inclusion in the official database, agencies not providing information in accordance with established formats, and a general lack of recognition of ATEC (OTC)'s preeminent role in data collection.

Establish consistent relationship among analysts, testers, evaluators, and issue proponents. TRAC, as the lead agency, directed that the analysis teams rely upon the issue proponents for functional expertise in the analysis process. TRAC would then be responsible for the analytic validity and disconnecting any proponent parochialism. However, for some issue areas, the relationship with issue proponents was not sufficiently established to allow the issue proponents to participate in the analytical process. As a result, several issue proponents disagreed with the contents of the feeder report forcing the study director to resolve these conflicts after the fact rather than as a part of the analysis process. This problem can be avoided in future AWEs by establishing consistent relationships between analytic agencies and issue proponents which lead to closer cooperation among the participating agencies.

Firmly establish the authority of the lead analytic agency and its study director. Although TRAC's authority as the DAWE lead analytic agency became well known to the participating data collection and analysis agencies, some DAWE participants did not initially understand TRAC's responsibility. Some agencies, particularly those resident at Fort Hood, habitually work with data collection and analysis agencies other than TRAC. Initial lack of understanding of TRAC's role in the DAWE resulted in TRAC occasionally experiencing delays in obtaining timely information regarding events impacting on the DAWE analysis. In most instances these problems were resolved through further coordination among the data collection and analysis agencies, but in some cases they were not. Firm and early establishment of the lead analytic responsibilities, that is, who is in charge overall, is required to circumvent these problems.

Define a common lexicon of terms across agencies. Throughout the DAWE planning and execution, there was confusion regarding the different use of the terms; issue, essential elements of analysis (EEA), measures of effectiveness (MOE) and performance (MOP), and collectable data elements. It took considerable time to realize that there was a problem and to come to some agreement on the use of this terminology. More importantly, it became apparent that these inconsistencies were affecting the ability to properly define the scope of the experiment. For example, the analysis community typically defines the MOE and MOP as the lowest elements to

be collected to assist the analyst in answering the sub-issues and EEA. However, in the testing environment, MOPs are used to further define the MOEs. Data elements, used to further define the MOPs, are the lowest element collected in the testing environment (e.g., number of times the system is used per hour). The confusion over these terms resulted in the analytic teams adjusting and readjusting their data collection requirements. A common lexicon of terms, appropriate for the experiment, should be established and agreed to early in the experimentation planning process.

Identify Warfighter Rapid Acquisition Program (WRAP) candidates and initiative data collection requirements early in analysis planning. WRAP candidates to be played in the DAWE were not identified until immediately preceding the DAWE. Additionally, some of the initiatives played in the DAWE were not available to the EXFOR in time for the conduct of proper training. This made the data collection and evaluation of these initiatives and WRAP candidates difficult and, in some cases, impossible. Early identification of data collection requirements for these systems is required. Once the WRAP candidates are fielded and the soldiers are trained, modifications to the systems must be kept to a minimum and, if made, followed by the necessary training. Early availability of the WRAP candidates to the EXFOR and identification of data collection requirements for the systems is required.

Simulation exercises (SIMEXs) preceding the DAWE were invaluable in supporting planning for the data collection and analysis process, but more time between them and the AWE is required. SIMEX I, conducted in June 1997, and SIMEX II, conducted in September 1997, provided excellent opportunities to field trial data collection and analysis procedures. This included determining the detail and focus of the data and how it should be collected. However, sufficient time did not exist after these events to react fully to lessons learned from them prior to the next event. For example, there were problems identified during SIMEX I in the observations database software and the insights database software (lack of flexible database search capabilities) to be used to support the data collection and analysis effort. There was not enough time, however, before the DAWE to finish development and verification of some of the proposed changes that would have improved the data collection and analysis effort. As the Army conducts other AWEs, however, data collection and analysis procedures will improve as these supporting systems mature.

SMEs should be selected who have no vested interest in experimental outcomes. Generally, SMEs shared the interests of the TRADOC school or center they represented. Generally, the SMEs were located at a particular location within the 4ID and were required to answer many issues. Although issues spanned several proponent areas, most SMEs were clearly focused on their own TRADOC school or center's issues. It became obvious that it was very hard for a SME to completely remove branch influence from their observations. A potential alternative source of SMEs for AWEs would be non-participating Forces Command (FORSCOM) unit(s), reserve components, retired members, and civilians. The SMEs should serve only as consultants to the analytic team.

Analysts must be more involved in the development of surveys, questionnaires and interviews. The surveys, questionnaires and interviews were developed by ATEC (OTC), with input from the issue proponents, to address questions from each study issue category. The

surveys, questionnaires and/or interviews were consolidated across each study issue category such that only one integrated instrument was developed for each soldier respondent. For example, similar questions posed from different issue proponents regarding different issue categories were consolidated into one question for the integrated instrument. However, even though the questions were sometimes similar across categories, the perspective from various issue proponents was different. Consolidating these questions lost the nuances of the issue proponents that developed them. Additionally, the EXFOR set a limit on the number of questions that could be administered to EXFOR soldiers. The process of developing these instruments is more complicated than simply including all questions and then reducing the number to an arbitrary total. It was difficult to determine the most important questions from each of the categories, thereby issue proponents were forced to reduce the number of their questions to a predetermined limit without regard to the relative importance of the category. The effective development and use of these instruments requires more coordination with the analysts to help reduce duplication and still ensure that questions will elicit the desired information. Additionally, early coordination with the EXFOR would help alleviate arbitrary limitations in questioning its soldiers.

The experimentation can benefit from pre- and post-exercise modeling, if sufficient time is available. The DAWE, like any other experiment that is conducted as part of a warfighter exercise, was constrained analytically because the exercise was not repeatable in a live environment due to time limitations and cost constraints. This reduced the potential to examine specific issues that require some comparison of alternatives, to include any comparison to a baseline capability. Typically, this limitation is overcome through employment of a model-exercise-model (M-E-M) approach where pre-exercise modeling is conducted to help focus the data collection and where alternatives are examined in a constructive model after the exercise. This approach, for example, was done as part of the TFXXI AWE. The DAWE, however, was followed almost immediately by a Board of Director (BOD) meeting where decisions regarding Force XXI would be made based on DAWE results. This prohibited consideration of employing a M-E-M approach which would have helped focus the data collection and would have enabled comparison of the EXFOR to a baseline Army of Excellence (AOE) division, as well as examination of additional issues. Future experiments, however, should consider use of the M-E-M approach, unless time constraints prohibit it.

3.2 *Execution Phase*

Employ a data collection and analysis process that provides the flexibility to respond to unforeseen scenario events and will enable the capturing of emerging insights from a warfighting perspective. Given that one can't plan for every eventuality, a process was put in place to collect the data from warfighting perspective and react to unplanned scenario opportunities for collecting insights. The CAP team was used to accomplish this in the DAWE. Prior to the DAWE experiment, the CAP team identified certain scenario events that could potentially impact key decisions in the battle. By knowing where and when to look, members of the CAP team were able to position themselves in various cells to observe operations during these scenario events and identify any insights. Additionally, the CAP team was called upon to collect information and analyze events unfolding in the free-play scenario that were not foreseen prior to the experiment. For example, when chemical weapons were used by the WCOPFOR,

this team was dispatched to observe the results. The data collection and analysis process must incorporate an evaluation from a warfighting perspective and have flexible procedures in place to handle these unforeseen experimental opportunities, to include the flexibility to rapidly change and tailor data collection and analysis approaches during an AWE.

Subjective observations from an AWE do not require the same level of control as data from a formal operational test. During the DAWE, all observations collected by the SMEs were subjected to multiple validity checks by not only ATEC (OTC), but by analysts and issue proponents as well. Some of these repetitive checks were unnecessary and slowed the data collection process. This was recognized during SIMEX I and adjustments were made to the data collection process to reduce the number of validity checks on the data, but this was not sufficient. While timeliness or any other measure of quality for subjective data should not be forfeited, the same quality control standards used for formal system tests are not necessary. Also, the closely held ownership of the data by data collectors limited the analysts' access and ability to review and analyze the data during the DAWE. The extent to which subjective data is controlled in future AWEs should be re-evaluated. The control of the data should not limit the analytic process.

There should be a single, consolidated data collection plan to produce a single database for use by all. Although this was always a stated objective for the DAWE, some organizations still conducted their own data collection effort to meet their own purposes. Consequently, the data collected were not included in the one formal DAWE database produced by ATEC (OTC) for use by the analysts and the issue proponents. This occurred despite several attempts by ATEC (OTC) and TRAC to formally integrate the data collection activities of all concerned.

The formatting of the data input into the DAWE database must be controlled. The DAWE database, because of its vast size, had a very slow load and response time. The database, for example, had some inordinately large files (e.g. several animated PowerPoint slide files of 150 megabytes each). Additionally, several fragmentary orders (FRAGOs) were input into the database as bit-mapped pictures. This took up a lot of space and affected the response speed of the database manager. A 1000-fold reduction in file size, and a corresponding reduction in access time, would reasonably be possible if they had been input as text files.

Analysts should participate in the interview process. Immediately after the DAWE, the Division Commander, Assistant Division Commanders, the Chief of Staff, primary staff, and selected O-6 level commanders were interviewed as part of the formal data collection process. These interviews were conducted with restricted participation from the issue proponents and analysts, again a carryover of formal test protocols. Because of this restricted process, analysts were not allowed to follow up on the responses of the interviewees. Analysts' participation in the interview process would enable them to ask spontaneous questions in response to interviewees' answers and, thus, glean more information.

The Center for Army Lessons Learned Collection and Observation Management System (CALLCOMS) database management system (DBMS) did not efficiently handle the large AWE database of observations. Analysts discovered in SIMEX I that CALLCOMS was not able to efficiently handle the number of SME observations (up to 3000 daily) expected from the

DAWE. CALLCOMS took an average of 90 seconds to display a single observation once the display sequence was initiated. Hence, each analyst would not have time to view the number of observations expected each day. ATEC (OTC) developed a replacement DBMS called “TexComs” which was a great improvement in responsiveness over CALLCOMS. TexComs was able to handle over 6000 observations from the DAWE with little reduction in speed of transactions. TexComs adequately captured SMEs observations and was user friendly with searches and features that met most analytical needs. Any replacement DBMS should have at least the features of TexComs. However, TexComs lacked the flexibility to do complex searches combining and/or excluding specific fields that should be added to any DBMS used in future AWE efforts.

Analysts should be permitted to serve as SME observers. Analysts could fill the positions of both SME observer and analyst by being granted unlimited access to the various locations within their area of responsibility. Access by analysts to various EXFOR headquarters was restricted because of the need to limit the number of observers, or overall number of personnel, in the EXFOR’s TOCs. Additionally, application of formal test protocols did not allow any analyst to directly interface with a SME when there was a problem (i.e., an anomaly) with an observation. This lack of direct interface forced the analysts to write instructions and inquiries back to the SMEs to resolve the anomaly. The anomaly resolution process took one to three days for an answer to come back to the analysts. In some cases, it took more than one request to get the information desired. This cumbersome process, which caused analysis results to be delayed in some cases well beyond when significant events occurred in the scenario, could have been avoided if analysts could have also served as, or along side, SME observers. If planned for early enough, this also would help to lower the number of SMEs needed, which was a concern and expense for the data collection community.

SMEs should be focused on issues, not on a geographical location. SMEs were severely restricted because of space limitations on where they could go in the TOCs. Because of the flow of information and coordination required among the TOCs, the issues of staff effectiveness, IO, and C2 cannot be resolved by observing only one TOC. Scheduled meetings among the SMEs were also not sufficient to permit the necessary exchange of information. Most SMEs need to be able to change locations to follow through on observations. SMEs could have been more effective if they were organized much like the CAP team, or perhaps like the BCTP OCs, under the leadership of the issue category analyst, and targeted to go where they needed to go.

The insight development process should be scenario event based rather than timeline based, and addressed by a team of analysts similar to the CAP team employed in the DAWE. Analysts experienced frustration in trying to develop insights on a periodic basis to support a daily briefing, the timing of which had little to do with what was happening in the scenario. Insights were based on scenario events, so the reporting should also be on a scenario event basis. Periodic (daily) reporting may give significance to an item when there may not be anything significant yet to report. Additionally, the development of insights should be done by a team of analysts focused on scenario events, such as the CAP team employed in the DAWE, rather than strictly by analysts looking at specific issues, or a category of issues.

There must be a more complete understanding of the analytical objectives of an AWE. Although the exception rather than the rule, the focus of some in the EXFOR was strictly on training (the fighting and winning of the battle), rather than on the answering the issues of the experiment. For example, the Engineer Brigade Commander, while not part of the Force XXI division Table of Organization and Equipment (TOE), continued to participate in the DAWE at the request of the Division Commander even though this limited the ability of the analysis team to address the issues associated with the loss of the engineer brigade headquarters. The data collected on engineer C2 within the division TOCs were skewed by the presence of an engineer brigade commander. Therefore, no conclusive evidence was collected on the adequacy of engineer C2 and staffing within the TOC. Additionally, the EXFOR controlled the composition of the questionnaires, surveys, and interviews and limited their application to selected individuals. The limitation placed on this collection effort limited the data available to the analyst and proponents. These instances of training emphasis tended to overshadow the analytical requirements of the AWE and presented challenges to the study team. A more complete understanding of analytical objectives by the entire EXFOR would enable an AWE to better meet the primary objectives of both the training and analytic communities.

3.3 *Post-Event Phase*

There must be allowances for analysis to be done concurrently with the AWE. In order to be responsive to its reporting requirements, the DAWE analysis team did much of its analysis concurrently with the DAWE execution. This worked well despite some natural discomfort among selected analysts regarding the need, in some cases, to analyze incomplete data before the end of the DAWE. It also enabled the study team to develop the daily insights briefing and to produce the IIR within thirty days after the DAWE.

The study director should use a post-AWE workshop to develop the final report. The DAWE Final Report was developed by integrating the written input from the participating analytical agencies after they had returned to their home stations from the DAWE. Any revisions, conflicts, or questions had to be resolved via FAX, telephone, and email, which caused delays in answering and coordinating refinements to the report. Furthermore, certain analysis team members being transferred, retired, or assigned other projects exacerbated these delays. The study director should hold a workshop with all analytic agencies immediately after the analysis is complete to develop the final report. This workshop would facilitate the cross-fertilization of ideas and provide an opportunity for resolving contradictory insights.

The IIR should be recognized as an emerging impressions report, not a comprehensive analytical report for an AWE. The DAWE IIR was so comprehensive, with over 75 pages, that once it was published, it ran the risk of being perceived by many as the final report based on a completed analysis. The quick response of thirty days to complete the IIR required analysts and issue proponents to conduct analysis of incomplete and emerging data to develop the initial input to the IIR. While there were no insights in the IIR that were contradicted after completion of the analysis, this possibility existed. If immediate feedback is required in addition to a comprehensive final report, then a short memorandum of emerging impressions should be adequate. Producing only one comprehensive report would allow more time for the analysis

team to review the completed database, resolve any conflicts, determine the key insights, and staff the final report.

An AWE database should be structured to best facilitate the retrieval of all data. The DAWE database structure did not account for the conditions in the DAWE that were different from the normal testing environment. These conditions included time constraints, multiple sources, and the diverse character of the data. This resulted in a format for the DAWE database that included a multitude of text files, smaller databases, spreadsheets, and graphics files. Because of this, the dendritic of directory names, sub-directory names, and file names were not always descriptive of the data they contained. This posed a problem to the analysts in finding the data and understanding its source and its relationship to the study issues. The database for an AWE should be more flexible to accommodate these conditions and provide a more intuitive, easily understood, and more accessible overall database.

Tools should be developed as part of the Joint Training Confederation (JTC) and used in the AWE to easily generate basic effectiveness information from the exercise.

The JTC, as a collection of training simulations that use unclassified and often aggregated data, does not generate effectiveness data that is useful to the analysts. It does, however, produce information of general importance which can be of use to the analysts (e.g., recording the history of the battle, tracking movement of units and the forward line of own troops (FLOT), and recording of basic unit maneuvers). In the DAWE, Vision 21 (an instrumented JTC after action review (AAR) tool) provided this information as well as damage reports, unit strength over time, mission and posture information, and equipment lists for each unit. Vision 21, or another similar tool, should be further enhanced and used in the future to assist the analytical community. The enhancements should include, as a minimum, providing information on the units in “red zone” fights (e.g., which units engaged, when, where, how long, what systems and ammunition used, etc.), providing the ability to graphically examine the battlespace down to a resolution of 10 kilometers by 10 kilometers, and providing equipment lists down to the smallest size unit portrayed in the training model.

4. Summary

In every successful operation, there are aspects that could have been better executed to achieve the objectives. This is especially true for new, evolving ventures, such as Army advanced warfighting experiments. The planning, execution, and reporting of data collection and analysis that underpinned the DAWE fulfilled the experimental objectives, but still should be refined and changed to improve them for future AWE. This paper’s lessons learned provide the basis for the necessary changes. The lessons learned strongly reinforce the need for the AWE planners, data collectors, and analysts to be innovative, agile, and adaptive throughout the planning and execution of the AWE process. The following paragraphs summarize the key lessons learned.

The data collection procedures routinely used for live operational tests in the field are not directly applicable to AWE. Limited adaptation of established procedures was made for the DAWE and further adaptation is required for future AWE.

Data collection should be a unified and synchronized effort under the direction of a single agency. Quasi-independent data collection by multiple agencies took place during the DAWE and should not be permitted in future AWE.

Careful and deliberate consideration should be given to the selection of the database management system with particular attention to the unique data processing and analysis needs of the AWE. Rather than simply a data repository, it must readily enable and enhance the attainment of the analysis objectives.

Analysts must have unrestricted contact and interface with the data collectors and observers/controllers who are working “in-the-box” (i.e., simulated environment) during the AWE, to include entering “the box” themselves as well as serving in a data collection capacity if necessary.

Because the typical AWE is a one-time event and the scenario is allowed to develop dynamically, the data collection effort must be able to rapidly respond to targeted areas of interest that are identified and cued as events unfold. Therefore, procedures should be developed to enable two types of data collectors for an AWE: those who are fixed in place (i.e., single physical location) to observe events in their assigned subject area, and those who are able to track subsequent events (i.e., physically move) triggered by and related to an initial event occurring in their subject area.

The final analysis and report must be concluded quickly following the AWE, while first-hand information is readily accessible from the many participants prior to their departure or reassignment to other duties.